

PYROTECHNICS 52

The Now & Then Newsletter of General Technics

ICU2

The Video Transmitting Rocket.

By: Chris Oesterling N8UDK

Introduction

Hello fellow GTers. I have recently concluded my "video rocket" project and wish to share my results with you. First of all, I realize people are doing this stuff quite a bit more often now. I can assure you I didn't want to reinvent the wheel here, or launch it for that matter! But even similar projects have different outcomes and I think it's meaningful to share the experiences. In retrospect, I had a very enjoyable time from start to finish and would gladly do it all over again.

Concept

I knew I wanted to build this "Video Rocket" for some time. No doubt the Tripolitan, er, High Power Rocketry magazine had a major influence on me. The concept was quite simple. A relatively light weight rocket containing only a transmitter, camera, and batteries would transmit NTSC video down to a receiving device that a video recorder would be hooked to. No problem, I would simply run out to K-Mart, pick up a miniature TV station, and slap it into a rocket. Well, to my surprise, K-Mart didn't have what I was looking for. Actually the clerk in their electronics department looked at me like I wasn't from this planet. (She was right.)

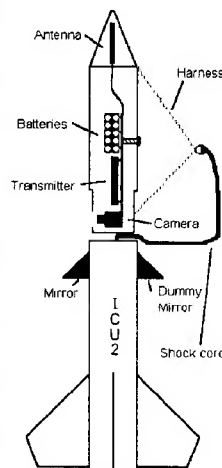
ATV

Very soon after being disillusioned at the local K-Mart, I found out about something called Fast-scan ATV. ATV stands for Amateur Television. Fast-scan Amateur Television uses a transmission format fully compatible with video equipment designed for the home. The video is amplitude modulated; the audio is frequency modulated. Each video frame consists of 525 horizontal lines with 30 frames transmitted each second. What you end up with is full motion, color video with a simultaneous sound channel. The transmission end consists of an antenna (mine is vertically polarized), a very small camera, a transmitter board, and of course some power source. To receive all that you need is an antenna (mine is circular polarized), RF converter (also called a down converter, it shifts the received signal to a standard VHF TV channel), and an unmodified TV set. Because the signals occupy several megahertz of bandwidth, the FCC does not transmit FSTV on bands below 420 MHz. My transmitter uses 439.25 MHz.

I need a license to do what?

Just like us Tripolitans need to be confirmed to use high powered motors, amateurs need to pass a few tests to receive an amateur radio license. To use my video transmitter legally I needed to get my HAM license. There's no question both are a privilege and much responsibility is involved which I do take very seriously. I did in fact received my license (tech no-code, or was that no-tech code) at this little event south of me call the Dayton HamFest. That day I also picked-up the electronics (transmitter TXA5-RC and down converter TVC-4G) from a company called PC Electronics. The camera (series V) was purchased from Micro Video Products. Ed's a real nice guy. I strongly recommend this camera, it very durable, as I soon found out.

OK, OK, back to the rocket. Next, I purchased a rocket called the "Quantum Leap" from Public Missiles Ltd. This all phenolic kit was quite good for what I had in mind. I didn't have to do many modifications to the rocket itself. Obviously I had to cut a hole in the payload section for the camera and a hole in the lower section for the mirror. Other than that I just made a harness and epoxied on the two mirrors. (Trying to keep the rocket symmetric I assumed was a good idea so that's the reason for the second mirror.)



The Optics

The camera looks into a mirror which is fixed to the rocket at about a 50-degree angle showing the ascent. Instead of the conventional method of having the mirror "flip" out after apogee which shows a view of the horizon during descent, the ICU2 separates and views the ground (using the harness) during descent. The payload section hangs from the parachute below the rest of the rocket.

Well, will it fly Mr. 486?

Yes said my omniscient computer. With the motor being an H142-10 and the total rocket weight being 3 1/2 pounds, diameter 3 inches, and drag coefficient of .25, the altitude reached will be 3,000 feet with a coast time of 8 seconds. Great! I even had a special directional antenna for playing hide-in-seek with the rocket (heh, just in case.)

Ready, aim, cry!

On July 25, 1992 was the moment of truth. The weather was acceptable. (If you don't like the weather



in Michigan just wait 5 minutes.) My friend Tom made several radio announcements to the local HAM's in the area that an ATV transmission would occur at 3 p.m. the area being the tip of Michigan's Upper Peninsula. Then the countdown came. 5, 4, my only concern was the mirror extended farther out from the rocket than I first anticipated. 3, 2, because of this I added the second mirror to insure a stable flight. 1, but it couldn't add that much more drag, could it? Launch!

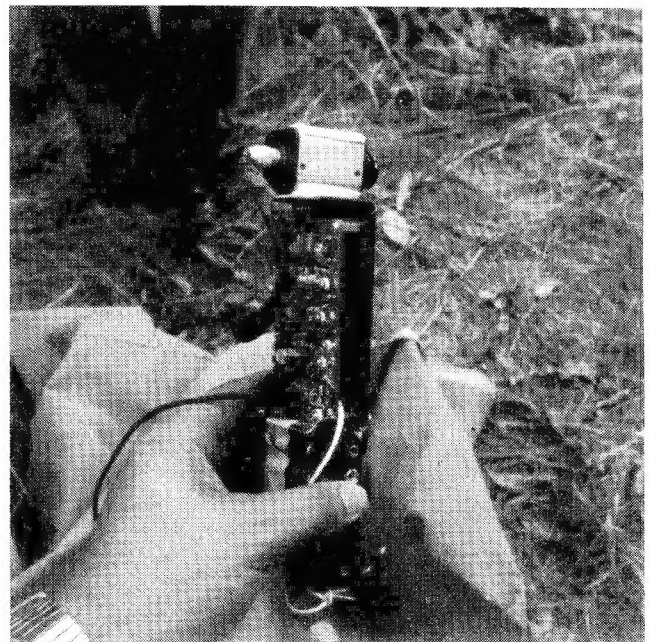
The longest 20 seconds of my life

The rocket lifted off the pad perfectly. It started to angle slightly to the left but it was fine. At around 600 feet the burn stopped. I compare the feeling that moment to my old car stalling when I would attempt to make a left turn at a busy intersection. Well apogee came and went. My rocket (very nose heavy now) started to return to Earth. Around 2 years, I mean 2 seconds into the decent the ejection charge separated the rocket. It separated not into one, but three pieces! Whew, the parachute landed a tree, it was safe what a relief. Oh, but what about my \$500 payload section? I don't remember the next few moments. Maybe in 20 or 30 years a hypnotist may answer this for me. What I do remember is peering over my motionless rocket that was laying on the ground. The rocket itself was broken in a few places at the top, the mirrors had snapped off. All in all the rocket wasn't in too bad of condition. The electronics and camera were all in the correct number of pieces. No obvious damage! A few batteries popped out. (I really did tape them in quite

well too.) After a few seconds of my shaking hands inserting two batteries that took more work than building the entire rocket I was transmitting once again! The electronics were fine. The only damage was a slight ding in the top of the camera.

Where's the rewind button on this thing?

After I settled down I realized my friends were watching the flight. From the oooh and ahhs I knew what ever happened up in the air was impressive. I then watched the tape and saw a perspective not normally seen. And impressive it was. Perfect video from the launch to the ground. Ironically the most impressive of all the video was noticed later when single stepping through the free-fall. It was awesome! My friends barn was in perfect view at about 800 feet of altitude. In another shot the lower section of the rocket was falling at the same time directly in front of the camera--neat!



Back to the old CAD program, I mean drawing board

The rocket is in need of some repair. The great thing about phenolic is just simply cut off the broken part and your rocket is slightly shorter but ready to launch again! The transmitter board (which outputs about a watt) and camera are in good working condition. I need to get 14 volts at 350 ma some other way than the 10 AA batteries though. Those batteries did make the rocket weigh much more than necessary.

Conclusion?

I have to assume that I had grossly under estimated the drag which made the rocket coast less, causing the apogee to occur sooner, which made the ejection delay too long. By the time the ejection charge did go off, the rocket was returning to the ground with a great amount of speed. It simply was ripped apart. But hey, live and learn right?

Thanks folks

Finally, I think it's important to commend the people who helped me in this project. They are: Tom Snoblen (N8AMX), Frank Uroda and Gerald Kolb of Public Missiles Ltd. (313) 468-1748, Ed Mitchell of Micro Video Products (714) 957-9268, Tom (W6ORG) and Maryanne (WB6YSS) O'Hara of PC Electronics (818) 447-4565, and my patient girlfriend Cindy Nelsch (N8PIH) whose phone number I'm not going to publish. Next year better video! See you then.

Quarks

• So you're probably wondering, "If this is Issue 52, what happened to Issue Fifty? The big one, the spectacular one, with a myriad of entertaining techietales, amusing photos, heroic exploits of days gone by? The one the *PyroTechnics* gang promised us, the one they begged us for material for? Did they forget it? Did they punt it?" Fear not, dear reader. It is in preparation and getting thicker every day. According to our Postmistress, Mary Lynn, "We have boatloads of stuff for Issue 50 and it will be well worth the wait, believe me!" We thought you'd like to read another issue while you're waiting for us to finish. Hope you like it.

• A project of Cap'n Al Duester's has recently become (somewhat) famous. With Dr. Al Bradley and others at Woods Hole, he's been building a robot submarine that can study one location for weeks or months on its own, then return to a mothership when it's time for pickup. The Autonomous Benthic Explorer has appeared in *Popular Mechanics* (see page 104 of the June 1993 issue) and *Discover*. But it really hit the big time when it was featured in that leading chronicle of our times, *My Weekly Reader*!

• Grazing a catalogue intended for herb fanciers recently, we encountered the Sleep Bunny. It's a sleepy-looking plush toy rabbit stuffed with a mixture of herbs intended to induce somnolence. Weird. Seems more like something you'd find in a D&D dungeon than in a mail-order catalogue. The manufacturers missed a bet by failing to equip S.B. with an electronic buzzer to simulate snoring... We wonder if there will be others in the series. Maybe a Hunger Bunny for dieters or an Assertiveness Bunny you can take to meetings with your boss?

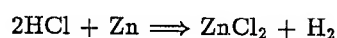
• Paul MacNerland, our favorite Promising Young Artist (because we can usually con him into doing a bunch of illos for *Pyro*), found himself Artist Guest of Honor at Duckcon in Lisle, Illinois this year. Nice to see the world recognize his talents. The Duckcon committee are cool people (many are GTers) who give out the Golden Duck award for the year's best children's SF. Also invited as Mad Scientist Guests of Honor were Barry Gehm and Bill Higgins. In addition to their usual science-slinging, they put on a liquid nitrogen demo that shattered quite a few bananas...

Home-Brew Hydrogen

Tim Eisele

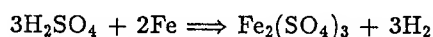
Since hydrogen is one of those Fun Gases that one likes to have readily at hand, it is nice to have a way of making middling-large quantities with common household chemicals. There are a number of reasonable reactions, and which one you select pretty much depends on what is on hand, and how much you value your life.

The type of reaction that immediately occurs to most people is one of the acid/metal reactions, such as HCl/zinc, H₂SO₄/iron, or (either acid)/aluminum. The HCl/zinc reaction is good from the standpoint of being well-behaved, but unfortunately it is well-behaved because the yield is not so good. Each atom of zinc produces one molecule of hydrogen, and consumes two HCl to do it:



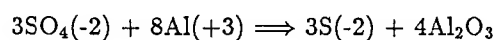
So, if you are using 30% Muriatic Acid (which is available in most hardware stores) and want to fill a 14" diameter balloon (23.5 liters, which at atmospheric pressure is about a mole of hydrogen, or close enough for government work) you will need about 66 grams of zinc (or about 27 post-1982 pennies) and about 250 ml of muriatic acid. The reaction is reasonably sedate, because it is not as strongly exothermic as some, but watch out for the HCl vapor, which you do not particularly want to breathe, and which will corrode stainless steel. Not ridiculous, but we can do better.

The sulfuric acid (preferably concentrated if you can get it) and iron reaction is also fairly well-behaved, but the concentrated sulfuric acid is a bit more hazardous to work with (but at least it is not likely to fume at you so much). The sulfuric acid is also a bit harder to get—at least the hardware stores in Houghton don't sell it. However, the yield is better:



or 37 grams of iron (unsoaped steel wool is good) and 53 ml of 98% sulfuric acid to make a mole of hydrogen. The only really serious objection to this one is that sulfuric acid is not really a household chemical. You can get H₂SO₄-based drain openers, but they have corrosion inhibitors that tend to slow the reaction with iron.

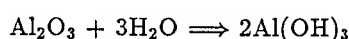
At this point, the obvious answer is instead of using iron to feed the acid drain-opener, use something more reactive, like aluminum. Unfortunately, this turns out to be a Bad Idea, for two reasons: First, the reaction is highly exothermic, plastic bottles melt, glass bottles crack, and boiling acid solution sprays around violently. Second, there is a particularly noxious side-reaction:



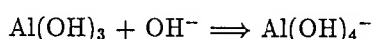
where the S(-2) immediately picks up two H+ to make hydrogen sulfide gas, which smells pretty evil and is an insidious poison (it deadens your sense of smell right about the time it starts approaching toxic concentrations, so you stop smelling it just before you keel over dead). I definitely Do Not Recommend This, unless you are eager to commit suicide in a particularly unpleasant sort of way.

Which brings us to my personal favorite, the aluminum/lye reaction. This has several advantages, including ready availability of all reactants, a somewhat less corrosive working fluid, few noxious gases, and a considerably better yield than the preceding reactions. This reaction actually proceeds in three steps:

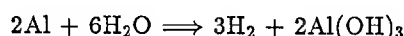
1) The oxide layer protecting the aluminum from corrosion hydrates (this can be a slow step in cold water)



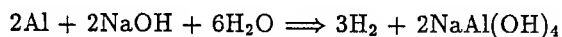
2) The hydrated oxide dissolves in the alkali solution



3) Then, the *water* reacts with the aluminum to make hydrogen and aluminum hydroxide (which dissolves by reaction 2)



Combining this all together, we get the net reaction



So, one mole of hydrogen only needs 17 grams of aluminum, 27 grams of lye, and a minimum of 36 ml of water (but use more water than this, at least 250 ml, so that the sodium aluminum hydroxide will all dissolve)

One persistent problem with the Al/NaOH reaction is that it starts out slowly, but then rapidly ramps up to a rather violent reaction. The reason for this is that the aluminum oxide hydrates poorly in cool water, and the solubility of the aluminum hydroxide is very temperature-dependent. Since the rate of reaction is controlled by how fast the oxide layer dissolves off of the aluminum, nothing much happens at first. You will be tempted to shake the bottle. Do not do this. Eventually, the heat liberated by the slow water/aluminum reaction will heat the water enough that the hydroxide dissolves almost immediately, and once this happens the reaction will run to completion in just a few minutes. The problem then is that you get not pure hydrogen, but a mixture of hydrogen and steam, which if you capture it directly into a balloon will be (a) too hot to comfortably handle, and (b) rapidly condensing, so your fine, plump, well-filled balloon will rapidly contract to a small, sad, soggy thing. A chiller of some sort is very helpful here.

What I use for this is a glass jar with a sealable lid (spaghetti sauce jars are good) with a hose fitting through the lid. The hose then goes to a second jar (peanut butter

this time) where it is bubbled through cold water and escapes through a second hose, which goes to the balloon. I advise using at least a 1/2" diameter hose, and a large peanut butter jar, so that the peak gas flow and significant amount of heat can be handled. To load the jar with reactants, put the dry lye powder onto the aluminum foil, and wrap it up loosely and stuff it into the jar. Then, add water and put on the lid. The combination of cold water and the delay before the water hits the lye will give you plenty of time. Putting the reactor jar into a bucket, to catch the shards if the pressure gets too high, is also a good idea. Once gas starts bubbling into the peanut butter jar, it is ready to take a balloon, garbage bag, or whatever container you wish. Incidentally, don't fill the reactor jar more than about half-full, because if you do the water will boil into the gas outlet, and then you *will* have a mess. If regular-grade aluminum foil reacts too fast for your peace of mind, you might want to go to the thicker oven grade, which has less surface area for the mass and so only reacts about half as fast. If this is still too fast, you might want to get some of the aluminum printing plates from the local newspaper, which are thicker yet but still thin enough to be cut into chunks with scissors (or even shredded with bare hands if you are willing to chance some serious cuts).

Quite aside from hydrogen's lighter-than-air characteristics, nobody seems to be able to resist lighting it off at some point. Unlike pure hydrogen, this stuff will burn with a nice, fluffy yellow flame because of the trace of sodium that gets into it. Very pretty on a dark night. Very pretty indeed...

On the Vidiotic Front

George Ewing, WA8WTE

*Shoot that Smerp, what a grouch
Drag that broad behind the couch...
If this violence offends
Burn a cockroach with your Lens!*
—James Corum Vavrik, 1973

Suddenly there is an embarrassment of NTSC riches, with lots of stuff showing up on the local tube and in video stores, ranging from fairly good to wretched Skiffy.

Close Encounters of the Fair Dinkum Kind, Mite!

The Time Guardian is so bad in places it really doesn't even deserve the term "Sci-Fi." It's sort of a low-budget Australian U.F.O. Biker Western, only the U.F.O.'s are really time travellers, including denizens of a Blish-style flying city with a dome over it and hordes of Orc-like Cyborgs in Toonish badguy battle armor. And you thought nobody could look as silly and at the same time shoot as badly as Imperial Storm Troopers! There are bits and pieces here that are interesting, including some neat FX and a couple of spectacular stunts, amid a sea of cliches stolen from a hundred other movies and old *Planet Stories* covers, but nothing makes much sense.

Actors include an embarrassed-looking refugee from *Quantum Leap*, Mr. Stockwell, an Asian Kung-Fu Wise Engineer: "Ah so, Honorable Cap'n. We Kinna keep her going any longer; 13.7 seconds more, Laddie, and the Kremulator field will collapse!" a handsome barbarian Mel Gibson Wannabee, and a lady geologist with nice thighs. D+

Return With Us Now to the Thrilling Daze of Yesteryear!

Most of the new SF series popping up are thinly disguised copshow/westerns. With *Space Rangers*, currently running in syndication, the disguise is so thin as to be invisible. Interestingly, the first episodes of both this show and the new *Star Trek/DSN* spinoff featured the same gimmick, a Chameleon corps shapeshifter; in *Space Rangers*, he's an assassin, in *STDSN*, he's a cop. Now that Michael Jackson can grab his crotch anytime and turn into a panther, it must be steam engine time for shapeshifters in TV SFX departments...

This show has some nice background and effects, much like the *Alien* movies, and some good character actors, including Oscar-winner, Linda Hunt. The plots are just *A-Team*-style shoot-em-ups, though, and the first few episodes have been scheduled locally on Wednesday nights, up against the more popular *Time Trax*, forcing SF fans to split their vote or buy more VCR tapes. *Space Rangers* may be canceled by the time you read this. D+/C-

Shane On You, Officer!

Time Trax has so far been a kind of hybrid of *Shane*, *The Fugitive*, and the other "Aliens among us" shows. The gimmick is that instead of Aliens, they're all from a toilet in the basement of the Smithsonian, 200 years in the future. This series is clearly designed to appeal to *Highway to Heaven* and *Quantum Leap* fans, so you can bet the hero'll rescue lots of cute but troubled kids and fall discreetly in love with lots of brave, sexy, young widows, etc. Look for the hero, Darien, to spend lots of macho time riding around shirtless on horseback or on a motorcycle with no helmet! Any resemblance to *Knight Rider*, from the hero's hunky haircut to having a snotty robot credit card instead of a snotty robot Pontiac is purely coincidental, of course. Look for him to lose his carkey beeper/phaser frequently, in order to justify lots of fisticuffs and Kung-Fu BS. C+

Many Are Kung, Fu Are Chosen

Speaking of Kung Fu BS Westerns, *Five Fingers of Death*, et cetera—He's Back! I've seen one good *Kung Fu: The Legend Continues* episode so far, featuring unemployed KGB goons trying to hijack a hotel in Toronto, being stopped just in the nick of by Caine, his kid, and Robert Lansing, reprising his aging intelligence character from *The Equalizer* Who's next, David McCallum, Sean Connery, Robert Vaughn, or Patrick McGeehan? Leo G. Carroll is gone, so they won't be bringing back Mr. Waverley. This show could become a kind of Canadian *Murder She Wrote* for unemployed Hollywood secret agents. C.

Deepsix Space: To Baldly Go where N.O.M.A.D. has gone before!

When I heard that bald, sinister, Avery Brooks was gonna be the skipper of the New Trek Space Station, in the Same Universe with Cap'n Jean-Luc, I figured it was a all a plot to sell Rogaine! Not So! Cap'n Sisco, unlike Hawk, has hair, but the Pharyngi are all bald. Nana Visitor as the Bajoran refugee officer with a cute, bony nose, and Quark, the sleazy Casino proprietor, steal the show. Unfortunately, the *STTNG/STDSN* universe is getting more and more like the Middle East all the time. The Pharyngi (The word means "foreigner" in Arabic, no matter how you spell it!) are apparently Saudis or Kuwaitis. The Bajorans seem to be Palestinians, and The Cardassians either Iranians, Israelis, or Iraqis, depending on your sympathies.

I had visualized the Station in *STDSN* as being more like the mining camp in *Outland*. Instead, it's just another Starship, in this case a donut-shape with horns instead of a flying saucer with upside-down pontoons. Still, it has possibilities, If they can only avoid the Roddenberry-era cliches of "Gods on the Bridge Again" and Yet Still Another Omnipotent Alien Intruder in a Sci-Fi bathrobe putting the crew on trial week after week. If "Q" shows up, I'm switching off faster than a laser cavity! C+/B-

Babbling On

After a number of frustrating delays, the 2-hour pilot of *Babylon-5* finally ran this week. Lots of special effects, and generally more plausible than its Trekkish competition. The opening plot features (you'll never guess) a shape-shifting assassin! Okay, so it's a regular alien assassin with a blaster wearing an illusion-generating field gadget instead of the balls-of-slime kind as in the other shows; like I said, steam engine time... The station is interesting, basically an O'Neill habitat with extra bells & whistles. You've got a Commander who looks & talks like Harrison Ford's older brother, A non-nonsense Asian woman XO, a West Indian doctor in Sickbay, and several interesting aliens. The Politics is very Laumerian ("To expect a Groaci Ambassador at any minute, Soft One..."). The station organization is much like Sector General Hospital in James White's books. The science is a little better than average Hollywood, though they're still making real-time 2-way interstellar phone calls, etc. Overall, A-

Silver Screen Dept.

Three Hollywood Movie versions of print SF classics are now out for 99 cents in the video stores:

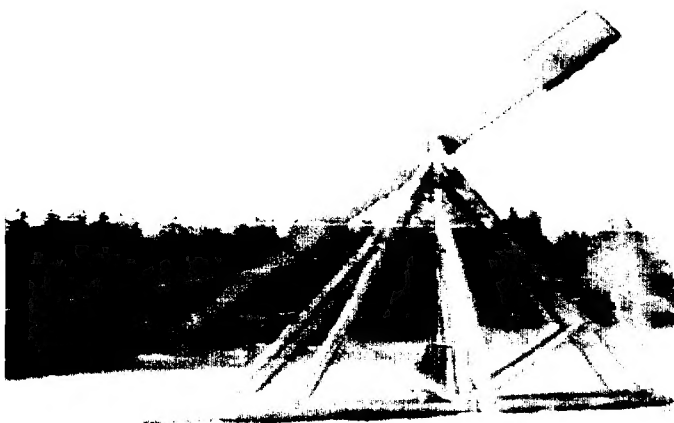
Freejack based on the Robert Sheckley "Immortality, Inc." classic, was surprisingly decent. People in the future are using a time transporter and stealing the bodies of disaster victims in the past just before they die, then using them for personality transplants, mindswapping in the brain patterns of rich future Trumpish executives who are about to die for one decadent reason or another, and erasing the minds of the original victims. Because of a screw-up, an occasional victim escapes without his mind being erased, and becomes a "Free Jack," an ultimate fugitive, legally dead and a trespasser in a body that is technically owned by the government / corporation. Nice hugger-

mugger, neat future cars, but slightly excessive chases and gunfights. Mick Jagger can actually act! B+/A-

Millenium is a variation on the same idea, based very loosely on the "Herb Boehm" short story, "Air Raid" in the very first Issue of *IASFM*. In this one, desperate time trippers from a dismal future are rescuing passengers from doomed airliners just before they crash in the past, using them as recruits and genetic breeding stock, and putting cloned dummy bodies back in their places to be found in the wreckage. Kris Kristofferson plays an FAA investigator who's being driven nuts by anomalies he finds in the affected crash sites, and who falls in love with an ex-Charlie's Angel who is a time-tripping stewardess from the future. Not Bad, considering they started with a ten-page short story. B

Total Recall is loosely based on the Philip K. Dick nov-
elette, "We Can Remember it for You Wholesale," which originally ran in *F&SF*. Arnold of the Mighty Thews plays a mild-mannered blue collar worker who stumbles into a paranoid nightmare of brainwashing, false implanted memories, plus secret police and terrorist hugger-mugger on the classic Mars of the SF Fifties. This is not Carl Sagan's Mars. This Mars has Canals, mining colonies, Alien ruins, Sleazy mutant ghetto redlight districts, and endless big-budget gunfights, chases, and blow-ups. B+

Inquiry: Last Year, the Aaron Spelling organization (the *Dynasty* gang) filmed a mainstream TV movie pilot in my back yard, tentatively entitled "Gulf City." Has there been any sign of it? My bit part is probably lost on the cutting room floor anyhow, but I'm curious...



NORTHERN EXPOSURE's trebuchet.

Anything Goes

by Fred Robinson

How to Build a Trebuchet

from *The Heterodyne Boys' Big Book of Fun*

Well, actually this is "How (and Why) I Built *My* Trebuchet" from nobody's book but my own. Well, maybe a few refer-
ences. And a TV show. And a Wall Street Journal article...

Where was I? Oh. A trebuchet (tray boo shay) is a siege engine of the rock-throwing type. Unlike a catapult, which uses the tension in a twisted bundle of cords to move the throwing arm, the trebuchet uses a counterweight on the lower end of the arm and the principles of leverage to move things along (figure 1). Working trebuchets are estimated to have had fifty-foot arms and counterweights up to ten tons, ranges of up to 300 yards (probably with lighter missiles) and projectiles of up to 300 pounds. This weight estimate is low, as mention is made in several places of dead horses used for projectiles (yech).

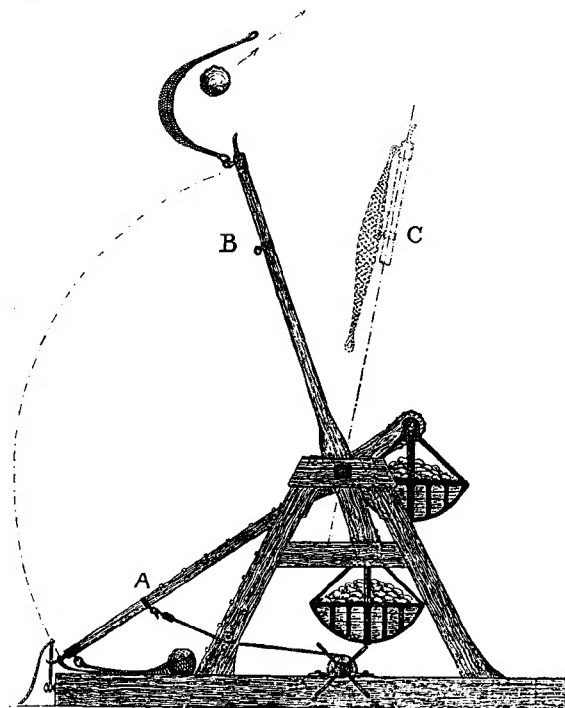


Figure 1. Trebuchet (copied from G.C. Stone).

My interest was first piqued by a 1991 Wall Street Journal article describing Hew Kennedy of Acton Round, Shropshire, England, who'd built a full-size trebuchet just for fun. He's thrown cows (dead ones), pigs (also dead), pianos (flaming and not), and small cars with it. It's not very portable. The counterweight alone is 6 tons of scrap steel, and the whole thing rings in at about 30 tons. A log framework supports the 60-foot arm, which holds a thirty-foot sling. Projectiles go from 0 to 90 miles per hour in 1.5 seconds, pulling 20 Gs of centrifugal force as they swing around. Its maximum payload is about 1400 pounds; its distance record is 112 pounds to 235 yards. It cost about £10,000 (\$17,000) to assemble. Hew has a "nutter cousin" with a smaller device, used to throw gaso-
line-filled toilets at local fairs: "Those Daring Young Men and Their Flaming Latrines."

Things were accelerated by an episode of *Northern Exposure*, in which Chris the artist decided to fling a cow for artistic reasons (what better?). When a friend told him that Monty Python had already flung a cow in *Monty Python and the Holy Grail*, he fell into a blue funk. Finally, he came across a burnt-out piano and flung that instead. The fling was filmed in overcrank, so it came out in slow motion, and was presented from several angles. A beautiful touch was the use of Strauss' "Blue Danube Waltz" as background music for the fling. (No, I never saw the flinging of the coffin.) The device was built for the show by Hew Kennedy.

I showed this sequence to members & accomplices associates of the South East Michigan Gluttony Society back around early 1992. From this came the first two downstate tries at trebuchets. Mine was a model made of Lego (wonderful stuff), embodying, in my innocence, several features which should not be done with trebuchets. It has a cup at the end of the arm for the projectile, and the motion of the counterweight is halted by an adjustable stop. Weighted with pre-1980 non-zinc pennies, it stands about a foot high with an eight-inch throwing arm. It can throw a small marble about a foot.

The other was instigated by Mike Wayne and Ken Farmer, and roughed out by Connie Trembley's dad, a pipe fitter with access to plenty of left-over materials. This one is still incomplete, but would stand about twelve feet high with an eight- or nine-foot throwing arm. The framework is two-inch pipe, and seems a bit wobbly in my humble opinion (photo 1). I fear for the uprights if they aren't braced.



Photo 1. Mike Wayne and Mike Elliot and the (partly-assembled) pipe-frame trebuchet (photo by the author).

A third device, fashioned by Tim Eisele, made an appearance at the 1992 Hoton Berserker. It stands about eight feet high with a six-foot arm. The counterweight is a five-gallon bucket of cement. Like the Lego model, it flings the projectile from the end of the arm and has a stop at the bottom for the counterweight (photo 2).

As shown in figure 1, a proper trebuchet lets the counterweight swing free and throws the projectile from a sling which releases automatically at the proper time. The sling is an important feature, because it greatly increases the range.

Without a sling, the projectile is thrown from the end of the arm. However, when the counterweight is not stopped at the lowest point of its swing, the projectile winds up right in front of the trebuchet. When the counterweight is stopped, the best place to stop it is before it reaches bottom, so that the projec-

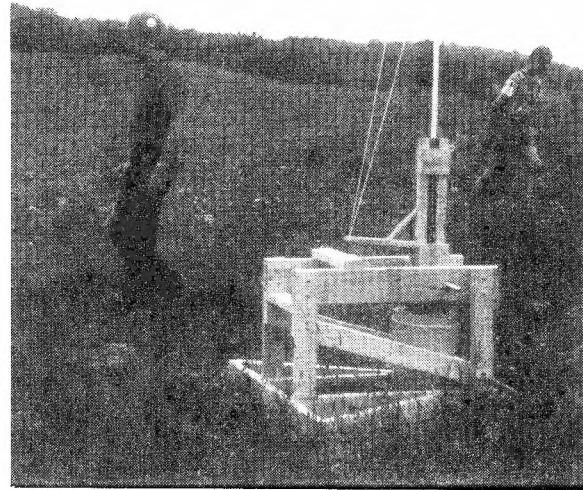


Photo 2. Tim Eisele and his trebuchet (photo by Kevin Nickerson).

tile exits with a good upward trajectory. In terms of energy, however, this is not optimal, as the counterweight is not moving at its fastest at this point. Finally, stopping the counterweight subjects the framework to severe shocks and would probably knock the thing to pieces fairly soon.

A sling increases the length of the throwing arm, thus increasing the speed at which the projectile moves at release. There are several designs of slings (figure 2). The kink sling uses an extra line to kink the sling and release the projectile. The regular sling releases one of its lines to release the projectile. A variation on the regular sling is the one-line sling, which gets flung along with the projectile. It has the advantage of not getting tangled in the arm as it swings back and forth after the launch, but you need a new one for each launch (unless you want to ask your targets to give it back to you). This last style is used on both of Hew Kennedy's machines.

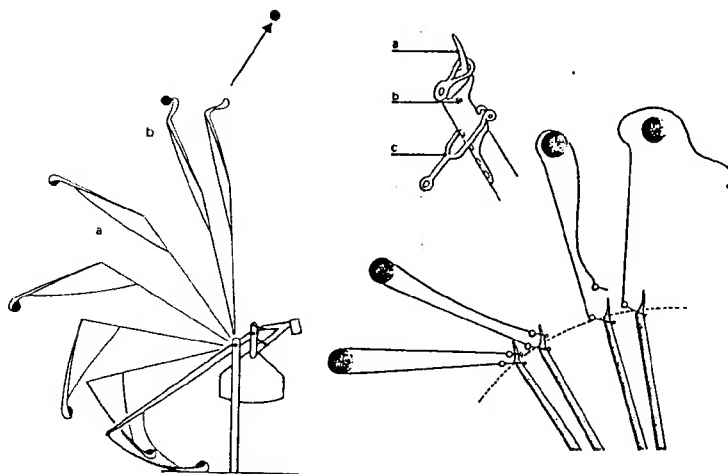


Figure 2. Sling designs: Kink (left) and regular (right) (copied from and © The Diagram Group).

In early 1993, I dreamed up a trebuchet design which seemed sturdy and could be knocked apart for transport. The frame is based on an equilateral triangle, with vertical and angled support members (figure 3). It can be scaled up fairly easily to the four-by-four level. This design is based on careful scrutiny of the *Northern Exposure* device combined with a few aesthetic and practical decisions.

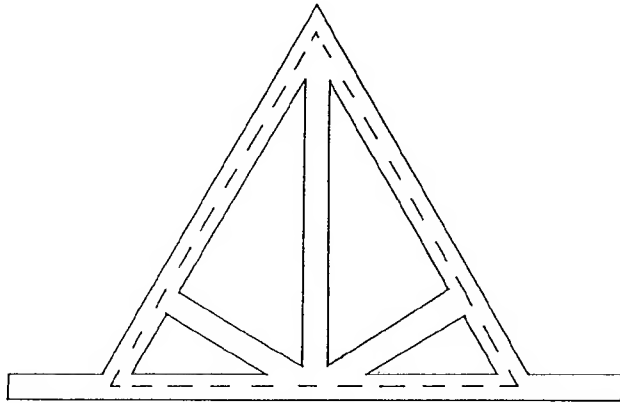


Figure 3. Side plan (outline) of the trebuchet frame. Dotted line is basic equilateral triangle. (drawing by the author).

I used simple ratios and angles in my design. The triangle (dotted line) runs through the middle of the frame members. Calling the sides of the triangle one unit, the base is one and one-half units long and the axle is about 0.866 units ($\sqrt{3}/2$) high. The arm is 2 units long. The upper throwing portion of the arm is 1.4 units ($\sqrt{2}$) long, so that it rests at a forty-five degree angle when cocked. The sling is also 0.866 units long so that the projectile rests under the axle before firing. These are, of course, idealistic measurements.

I made the prototype with a one-foot triangle, using three-quarter-inch pine. Design of the various joints took most of the drawing time (figure 4). Construction began when the weather turned warm, as my workshop is my side porch.

Rough-and-ready is my construction method. I marked the cuts directly on the wood, replicating the motions I'd made on paper, and then checked them against a full-scale drawing before cutting. They came out pretty close most of the time. I used a dovetail saw to make the preliminary cuts, and a good sharp wood chisel to carve out the notches. The members are held together with 1-1/2" by #10 wood screws.

The arm is a two-foot length of half-inch iron pipe, sixteen inches above the axle and eight below. I reckoned that an arm made of pine would not be strong enough for my purposes. The axle is a quarter-inch threaded bar, which allowed me to secure the arm in the middle with nuts and lock washers, keeping it from wandering. The axle rests on two bearing wheels originally intended for use in a sliding glass door. The bearings are secured to the axle with nuts and lock washers as well.

The bearings rest in form-fitting slots at the peak of the triangles, so that the axis of the axle is at the uppermost vertex of the triangle. I had thought that I would need to secure the bearings in some fashion, but due to the serendipitous design of the slots, this turned out to be unnecessary.

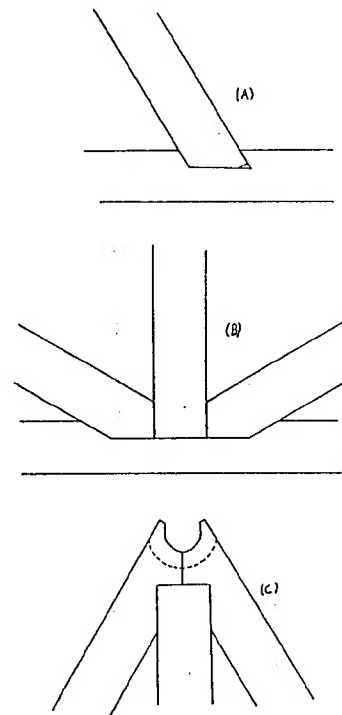


Figure 4. Detail plans of the frame joints. (A) Base corner of triangle. (B) Base of center support showing angled brace. (C) Top of center support showing bearing slot (dotted line). (drawings by the author).

The counterweight is ten or so pounds of old type metal in a Progresso soup can (Progresso soup comes in 15-ounce cans, half again as large as Campbell's). The type metal, a lead-antimony alloy, was melted directly in the can around the end of the arm with a propane torch. An end cap on the submerged end of the arm prevents it from slipping out of the counterweight. The arm wound up a bit off center as the ring stand that was supporting the whole mess started flexing about halfway through. Also, I am not sure that the can is completely full of metal; there may be a few voids due to my inexperience at using a propane torch.

If you have access to lead sheet or blocks, you need not go through the hassle of melting it. Such stuff can easily be bolted to the lower part the arm, and the soup can may be dispensed with.

Figure 1 shows the counterweight as a basket filled with rocks and stuff, hanging from a pivot. This design makes for easier transport of the larger-sized trebuchets, since the counterweight can be made from local materials. In addition, the range can be adjusted simply by adding or removing rocks to or from the basket. Being lazy, I didn't want to fool around with the extra work needed to construct such a design on the one-foot model.

The arm-release mechanism is a simple hook-and-eye hook which catches a loop of wire attached to the arm. A string allows one to release the arm from a safe distance.

The sling is a regular sling, made from cotton string and a piece of denim for the pocket. The hook at the end of the arm is the point from which the sling detaches one of its ends and is a headless wood screw bedded in a hunk of wood jammed into the end of the pipe (figure 5). According to the Diagram

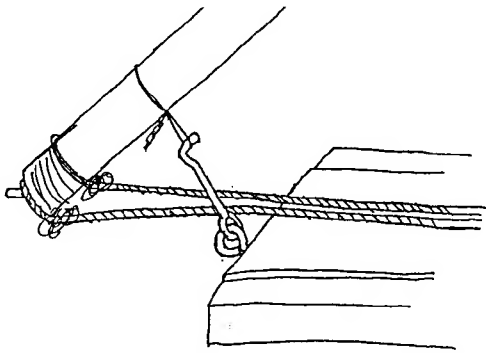


Figure 5. Close-up of the arm showing the sling hook and the release mechanism. Imagine a string running from the crook of the hook-and-eye hook to your hand (drawing by the author).

Group's description, the angle of this hook is critical to achieving the proper release point. I have not had an opportunity to verify this.

The two two sides of the frame are about four inches apart, allowing a bit of clearance for the counterweight. Sheets of cardboard are stapled to the spacers to provide a smooth surface on which the projectile can slide during launch.

Photo 3 shows the completed contraption. As the trebuchet has a tendency to slide back and forth when used on smooth surfaces, I weight it down with a couple of five-pound dumbbells. One must pull the release string gently without jerking it, lest the entire setup be twisted around, sending the projectile through the nearest window.

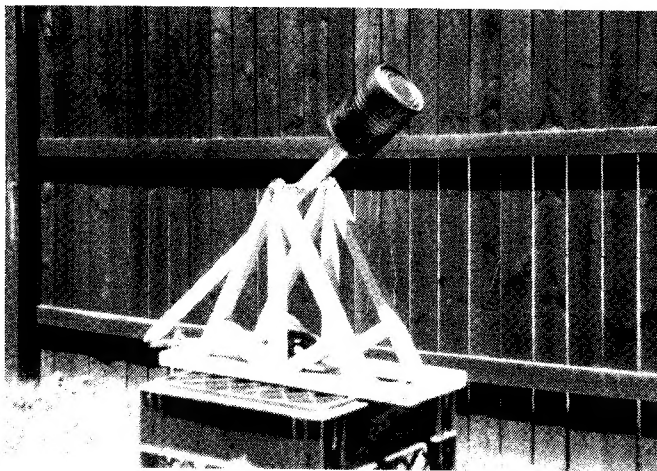


Photo 3. The completed small trebuchet (photo by the author).

Three different rocks (50g, 80g, and 130g) are all consistently flung about 26-27 feet. The heavier ones roll farther after the first bounce. A much larger rock (285g) reached only 17 feet. Contrarily, a very light smoke bomb barely cleared 6 feet, probably because there wasn't enough weight to swing the sling fully out.

One feature of Hew Kennedy's trebuchet's missing from my design are lateral supports, which keep it from falling over on its side. I am contemplating adding some splayed "feet" to my machine to attend to this. The feet would also provide a dandy place for the dumbbell weights that keep it from sliding.

I will admit that I probably overbuilt the thing, at least for one of this scale. The design is purely empirical, based on what looks good rather than calculations and stress analysis. I expect that when scaled up to a five-foot triangle made of four-by-fours (my ultimate goal), the various members will not fly to pieces on me. The piece with the greatest strain is the arm itself. A sufficiently strong one can probably be made by laminating (if such a term can be used here) several two-by-fours together. I have not worked out the best counterweight for a device of this size. I may be forced to design a pivoted counterweight basket for portability's sake.

Materials (approximately):

3/4" square pine moulding, about 10-11 feet
1/2" iron pipe (3/4" inch outside diameter, 2 feet long
end cap for iron pipe*
1/4" metal rod, threaded, 6 inches long
soup can*
small bits of type metal or lead*, or lead sheet, or lead blocks,
about 10 pounds
sliding door wheels (metal, not plastic) with bearings
1-1/2" by 10 wood screws
cardboard
string
cloth for the sling pocket
hook-and-eye hook
picture wire

*Needed only if you're going to melt the counterweight.

Total cost, about \$25.00 US (I got the type metal for free).

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